ceivingly at variance with experimental fact.

Reactor Physics impresses me as a good book, a solid introductory text with particular strength in the more mathematical aspects of reactor theory. Teachers can probably guide students across the few rough spots and fill the remaining few gaps in the treatment of introductory-level subjects.

Professor John M. Carpenter has served for nine years on the faculty of the Department of Nuclear Engineering at the University of Michigan, teaching both graduates and undergraduates in fields of introductory nuclear engineering, reactor theory, reactor power plants, the laboratory in nuclear measurements, and the nuclear reactor laboratory. His research interests lie in measurements of slow-neutron inelastic-scattering cross sections, neutron diffraction from glassy solids, time-dependent neutron thermalization, reactor noise, Cerenkov detectors, proton-recoil fast-neutron spectroscopy, and in the development of intense, pulsed slow-neutron sources. He has worked closely with Argonne National Laboratory and with Los Alamos Scientific Laboratory, and is now on leave, at Argonne, working on the program to develop the intense neutron source, called ZING. He is vice-chairman of the Michigan Section of the American Nuclear Society.

Neptunium-237, Production and Recovery

Authors	Wallace W. Schulz and Glen E. Benedict
Publisher	U.S. Atomic Energy Commission Office of Information Services (1973)
Pages	85
Price	$3.00 (paper bound)
Reviewer	Archie S. Wilson

Neptunium-237 is the precursor to ^{238}Pu; and ^{238}Pu, an alpha emitter with a half-life of 87 yr, is a prime candidate for remote power sources currently used in heart pacers and space applications. Space applications have required the larger amount of plutonium; resting on the moon are three devices, each containing 4 kg of ^{238}Pu. Future ^{237}Np will come from power reactors, and the estimated amount of ^{238}Pu which could be available by 1980 is ~300 kg annually. According to the authors of *Neptunium-237, Production and Recovery,* these considerations have generated the interest in ^{237}Np recovery.

Since between them the authors have about 50 man-years of experience in chemical processes for the recovery of actinide elements from neutron-irradiated nuclear fuels, they are well qualified to review neptunium processing. Their review is written for the process engineer who may be faced with the prospect of recovering neptunium from his or her plant. The language and jargon of the process engineer are used throughout to describe the variations on processing schemes. The review is organized into three sections: (a) Neptunium-237 Supply and Demand, (b) Recovery of Neptunium from Aqueous Solution, and (c) Nonaqueous Methods for the Recovery and Separation of Neptunium. The major part of the review (52 pages) is devoted to the aqueous systems. These aqueous systems are subdivided into solvent-extraction processes, ion-exchange processes, precipitation processes, and then two sections on the separation of ^{237}Np and ^{238}Pu and neptunium recovery in commercial reprocessing plants. The section entitled "Solvent-Extraction Processes" is further subdivided into Purex process recovery schemes, recovery by the redox process, Idaho Chemical Processing Plant recovery scheme, solvent extraction from Purex process wastes, recovery from fluorinated ash, and other solvent-extraction recovery experience. This listing of sections indicates that the authors' choice of organization was to describe the knowledge of neptunium processing in terms of particular plant experiences. Included with these descriptions are over two dozen flow sheets used by the various plants. From the point of view of a process engineer already familiar with the chemistry of the actinide elements, this organization has value in that the experience of a particular plant can be studied and operating details compared. From the point of view of a chemist wishing to understand the chemistry involved, this organization has minimal value. Those unfamiliar with neptunium chemistry should consult the standard texts and reviews to which the authors refer. One section is, however, devoted to one aspect of neptunium chemistry, the oxidation of neptunium. This section, "Process Neptunium Chemistry," describes the lack of agreement among investigators on the rate of the nitrous acid-catalyzed oxidation of Np (IV) to Np (VI) by nitric acid. This lack of agreement is surprisingly not unexpected since the nitric acid—nitrous acid equilibrium and the initial rate of nitrous acid decomposition depend on the partial pressure of nitric oxide in the system. However, lack of knowledge about the details of this oxidation has not impaired the operation of the processes described. Each plant has its favorite technique for oxidation state adjustment for neptunium recovery.

In this review, the authors have summarized these published plant experiences without critical comment as to whether a particular process could, in their opinion, have been made more efficient or better. Personally, I would have liked to have known what Schulz and Benedict thought about a particular process they described. Certainly, from my personal knowledge of these two competent scientists, they are not without opinions. Without opinions, the review lacks some excitement; nevertheless, those readers wishing to obtain a succinct review of neptunium processing will find this volume necessary reading.

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